Defense Policy:

COMMANDERS DIGEST

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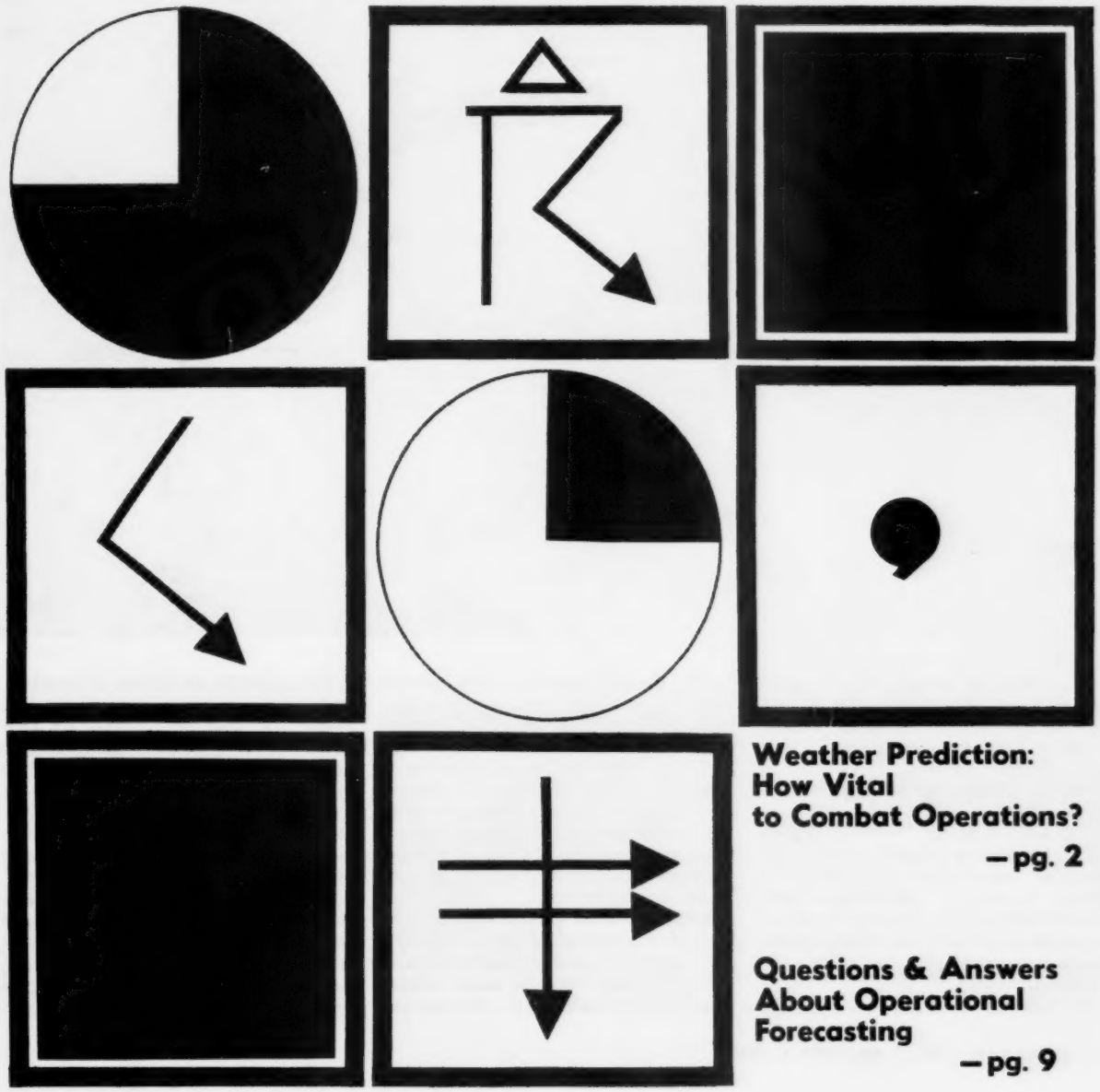
DoD METEOROLOGICAL SERVICES



Weather Prediction: How Vital to Combat Operations?
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Questions & Answers About Operational Forecasting
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How Weather Forecasts Affect Combat Operations

Environmental services are essential to the success of air, ground, and naval military operations; therefore, the Department of Defense must maintain dedicated weather services as integral elements of military combat forces. These are the Air Force's Air Weather Service, the Naval Weather Service, organic Army operational support units and appropriate research and development activities. This issue of **Commanders Digest** concentrates, however, on operational environmental services but also includes weather, oceanography and space environmental support.

As stated by the Joint Chiefs of Staff (JCS), military meteorological services are worldwide, specialized services organized to satisfy unique military requirements. Mobility, responsiveness to command combat-readiness and alertness to new weapon systems concepts are criteria for such services. Wherever possible, the Department of Defense uses the basic meteorological services of the Department of Commerce and foreign national weather services.

Requirements of general military users include: meteorological information specific to the particular weapons system being developed or employed; unique forecasts and analyses for command and control systems; specialized information, such as ballistic data required by field armies and naval units; specialized forecasts; impact prediction, meteorological advisory services and post-test analysis assistance to research, development, test and evaluation sites; and general meteorological support for training and deployment of military forces and contingency operations.

These environmental services are provided by DoD analysis, forecasting and observing facilities in the United States and abroad; aerial reconnaissance forces; meteorological satellites; air-transportable vans capable of housing deployed me-

teorological support equipment and personnel to support tactical operations; and a global military communications network.

In-house environmental services include:

- The Defense analysis and forecasting facilities at the Air Force Global Weather Central (AFGWC) at Offutt Air Force Base, Nebraska; the Fleet Numerical Weather Central (FNWC) at Monterey, California; the Joint Typhoon Warning Center (JTWC) at Guam; and other forecast centers in Europe, the Pacific and the Far East. Specialized centers—such as the U.S. Air Force Environmental Technical Applications Center (USAF ETAC) at Washington and the U.S. Army Atmospheric Sciences Laboratory at White Sands, New Mexico,—also fulfill unique military meteorological requirements.
- The Defense aerial reconnaissance force, which plays a paramount role in specific military operations. It provides en route weather observations for refueling, tactical deployments, and contingency exercises, wind information for mass airdrop exercises, and weather observations in missile recovery areas.
- Defense observation facilities operated to obtain data in direct support of military operations. Their reports are made available to other Federal agencies whenever possible.
- The Automated Weather Network (AWN), operated and maintained by the U.S. Air Force, which is the backbone of the military weather communications system. It consists of four real-time communications switching computers at Carswell Air Force Base, Texas; RAF Croughton, England; Fuchu Air Station, Japan; and Clark Air Base, the Philippines, linked by high-speed data circuits. The overseas Automatic Digital Weather Switches (ADWS) collect data from radio intercept sites and low-speed feeder circuits. These data are transmitted at 3,000 words-per-minute (wpm) to the Continental United States (CONUS) ADWS at Carswell Air Force Base where the information is examined, sorted, edited, and compiled into specific weather messages, and switched to military and civil customers. Besides low-speed distribution to Department of Defense weather units, data are transmitted by high-speed circuits to the Air Force Global Weather Central (AFGWC), Fleet Numerical Weather Central (FNWC), National Meteorological Center (NMC), and the Weather Message Switching Center (WMSC) at Kansas City, Missouri. All circuits are full-duplex, permitting a total exchange of data—both raw products from field units to the military and civil processing centers and products from these centers to the field centers.

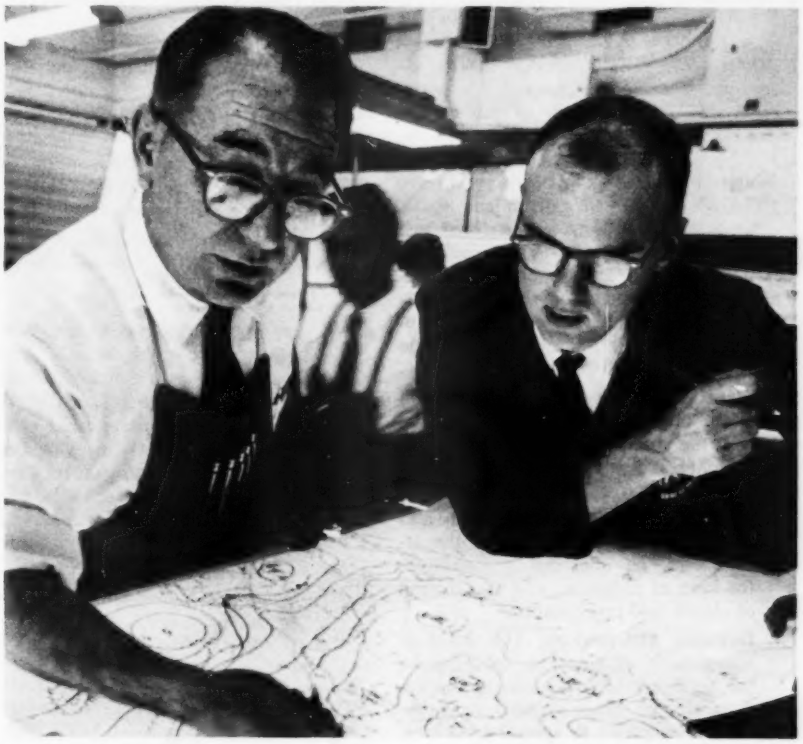
The CONUS Meteorological (COMET) Teletypewriter System is the primary communications system for collecting, editing, and disseminating environmental data at military stations in the United States. It consists of three teletypewriter networks: COMET I, COMET II, and COMET III. Each of these teletypewriter networks is sub-divided into eight geographical areas. The COMET I Network consists of half-duplex 100 wpm loop circuits used for collecting and disseminating airways data. The COMET II Network consists of full-duplex 100 wpm loop circuits used for the collection and dissemination of operational weather products and data. The COMET III Network consists of half-duplex 375 wpm broadcast circuits used for disseminating synoptic data.

Budgetary Aspects

The general curtailment of activities within the Department of Defense, fiscal austerity, more sophisticated weapons and command and control systems and continued automation are resulting in restructuring of selected functions and a

COVER

The weather symbols depicted on the cover are, top row from left: amount of cloud cover over a station, broken; thunderstorm with hail; smoke or haze. Second row: lightning; amount of cloud cover over a station, scattered; drizzle. Third row: tropical cyclone, typhoon or hurricane; heavy drifting snow (early symbol).



WEATHER NETWORK—Members of the Air Weather Service's Asian Weather Central at Fuchu Air Station, Japan, discuss placement of weather lines on a surface map. The Asian Weather Central is part of the worldwide Automated Weather Network.

U.S. Air Force Photo

significant reduction in manpower. In light of this, the specific objectives of the Department of Defense to meet the demand for essential environmental services in the future include the following:

- Improvement of the means for meteorological data management, including the collection, dissemination, evaluation, processing, storage, retrieval, display and quality control of meteorological data and the processing of data into meaningful and necessary predictions of meteorological conditions.
- Provisions for near real-time meteorological support to weapons systems and tactical operations by the development of new systems such as the Meteorological Data Sounding System AN/UMQ-7(V) and the Automatic Meteorological System (AMS), the purchase of five air-transportable Tactical Weather Systems (TWS) and six self-contained tactical weather radars. The AMS is being designed to receive, organize, integrate and provide the numerous meteorological data (such as those obtained through standard observation, meteorological satellites, and remote sensing devices) in the specific form required by the user (aviation, artillery, combat commander) on a near real-time basis.
- Identification of the impact of environmental conditions on weapons systems and military operations.
- Determination of the atmospheric effects on transmission, refraction, and scattering of acoustic and electromagnetic energy and on dissemination of aerosols and radioactive fallout.
- Rapid conversion of meteorological information into such terms as may be useful to, or required by, operational commanders or be useful in the operation of weapons systems.
- Improvement of weather observations, analysis, and prediction. Automatic observing and reporting systems for rapid, accurate observations of meteorological parameters are required. Improvements are also necessary in the unique observation equipment to support land and sea-based aircraft operations.
- Computerized systems for analyzing data and for providing accurate long-range weather predictions are required for all regions of the earth. Particular emphasis is placed on extending the present capabilities of prediction to the Tropics, Arctic regions, and the Southern Hemisphere, as well as local weather forecasts.
- Development of techniques and methods by which observations from mesoscale surface networks may be used to increase the accuracy of terminal forecasts.

Important Terms

Weather Words Commanders Should Know

Atmospheric sciences: The sciences concerned with the physical and chemical properties, the composition, behavior and processes of the planetary atmospheres of the solar system.

Meteorology: The portion of the atmospheric sciences concerned with the physics and chemistry of the earth's atmosphere as a continuum. This includes problems of the troposphere, the stratosphere, and the mesosphere, and studies of such phenomena as the general circulation, weather systems, precipitation processes, turbulence, diffusion, and atmosphere/surface interactions. Meteorology areas of interest extend from the surface to approximately 50 kilometers above the earth.

Planetary Atmospheres: The portion of the atmospheric sciences concerned with the studies of extra-terrestrial atmospheres.

Physical Meteorology: The study of the optical, electrical, acoustical, and thermodynamic phenomena of the atmosphere, its chemical composition, the laws of radiation, and explanation of clouds and precipitation.

Dynamic Meteorology: The study of atmospheric motions as solutions of the fundamental equations of hydrodynamics or other systems or equations appropriate to special situations, as in the statistical theory of turbulence.

Observation: The functions of sensing, measuring, or otherwise determining the state of the atmosphere and the magnitude of its phenomena. Computations, recordings, interfacing with communications systems and observations directly associated with these actions are part of this category.

Description: The functions of analyzing meteorological variables and describing the existing state of the atmosphere whether done by manual or automated methods and including related operations such as data plotting, forecast verification, interfacing with communications systems and further including climatology as related to the study of long-term manifestations of weather and the application of climatic data analysis to the solution of specific design or operational problems.

Prediction: The function of preparing forecasts of meteorological variables and phenomena whether done by manual or automated methods and including related operations such as interfacing with communications systems.

Dissemination: The functions of communicating meteorological information, displaying it, and disseminating required service products to users, including message composition, handling, relaying and editing, preparation of local area meteorological charts, and presentation of briefings and forecasts to users.

Systems: The integration of efforts in the various functional categories of meteorology into a coherent research pattern or organized set of development procedures.

Support: The provision of support to research, development, test and evaluation activities.

Air Weather Service

Meteorological, Environmental Services Provided

The Air Force Air Weather Service (AWS) provides general and special meteorological / aerospace environmental service to the Air Force and Army.

Air Weather Service dates from July 1, 1937, when the weather function was transferred from the United States Army Signal Corps to the Army Air Corps. Included in this transfer were 22 officers, 180 enlisted men, and 40 weather stations, 5 of which were located overseas.

To provide surface and aerial weather support on a global basis, the Air Weather Service collects worldwide weather observations. These observations are gathered primarily by surface observing stations located throughout North America, Europe, Asia, the Polar regions, and Pacific islands. This information is supplemented by data from other agencies in the worldwide meteorological community.

Observations from surface stations are supplemented as necessary by data from AWS aerial weather-reconnaissance operations and from weather satellites.

Using specially instrumented RB-57Fs, RB-57Cs, WC-130s and WC-135s, weather reconnaissance units fly about 63,000 miles every day. They travel along predetermined tracks from Guam, Japan, Hawaii, Alaska, California, New Mexico, and Mississippi, making thousands of observations.

Weather crews and aircraft based in Mississippi, California, Guam and Japan fly tropical storm-reconnaissance missions each season to collect data for use in providing advance warnings of the location, intensity, and structure of hurricanes in the Atlantic, Caribbean, and Eastern Pacific, and typhoons in the Western Pacific. The aircraft actually penetrate the storms to collect this data used by forecasters.

Scott AFB Headquarters

Operations of the worldwide system are directed from AWS headquarters at Scott Air Force Base (AFB), Illinois. The organization is composed of five ground (nonflying) weather wings, 11 ground weather squadrons, and an aerial reconnaissance wing with 5 flying squadrons. Under these parent units are the Global Weather Central (AFGWC) and the Environmental Technical Applications Center (ETAC), 169 detachments, and 109 operating locations. Nearly a third of the detachments and operating locations are outside the Continental United States.

AWS is organized to be responsive to the meteorological needs of Air Force major commands and Army organizations. Each ground weather wing serves as the weather-support agency for one or more commands, and the commander also serves at staff meteorologist for the commands his wing supports.

This functional structure, carried down to the operating level, promotes responsiveness to each command's specific weather support requirements and permits AWS to serve its customers more effectively. The staff weather officer, at whatever echelon he serves, acts as the

U.S. Air Force Photo

RADAR WEATHER—Air Force Captain Mara Osolin and 2d Lieutenant Thor O. Nilsen of the 6th Weather Wing, Andrews Air Force Base, Maryland, compare movement of storm echoes from a weather radar with the storm's past position plotted on a transparency. The 6th Weather Wing supports Air Force Systems Command, Headquarters Command USAF, and the Army Materiel Command.

U.S. Air Force Photo

RECONNAISSANCE — Two Air Force technicians at Kirtland Air Force Base, New Mexico, assist an aircrew member into his pressurized suit prior to a weather reconnaissance mission. Air Force crews fly specially instrumented RB-57F, B-57C, WC-130 and WC-135 aircraft on weather reconnaissance missions.

environmental advisor to the military decision-maker.

Weather Wings

The weather wings and organizations they support are:

1st Weather Wing, Hickam AFB, Hawaii, supports the Pacific Air Forces, U.S. Army Pacific, and Air Force and Army units in Southeast Asia.

2d Weather Wing, Ramstein AB, Germany, support U.S. Air Forces in Europe, U.S. Army in Europe and the U.S. European Command.

3rd Weather Wing, Offutt AFB, Nebraska, supports the Strategic Air Command, Joint Strategic Target Planning Staff, Aerospace Defense Command, Alaskan Air Command, Air Force Academy, Air Training Command, U.S. Army in Alaska, North American Air Defense Command/Continental Air Defense Command, and U.S. Army Air Defense Command.

5th Weather Wing, Langley AFB, Virginia, supports the Tactical Air Command, Air Force Reserve, U.S. Army's Training and Doctrine Command and Forces Command, U.S. Readiness Command, U.S. Southern Command, Military Airlift Command, Air Force Logistics Command, Air Force Communications Service, Air University, and other units.

6th Weather Wing, Andrews AFB, Maryland, supports the Air Force Systems Command, Headquarters Command, USAF, and Army Materiel Command.

9th Weather Reconnaissance Wing, McClellan AFB, California, supports all Air Force and Army needs and the requirements of other Federal agencies with its wide-ranging weather-reconnaissance aircraft.

In addition, several specialized units provide tailored support to a broad cross-section of users without regard to functional considerations. The Air Force Global Weather Central, the Environmental Technical Applications Center, and the Aerospace Environmental Support Center each produces specific products or services to satisfy the special needs of various agencies. A worldwide mobile weather-support capability is provided through the 6th Weather Squadron (Mobile), a unit of the 5th Weather Wing.

The 5th and 2d Weather Wings also provide specialized support to both the Strategic Army Forces (STRAF) in the Continental United States and U.S. Army in Europe organizations in the field. These specialized AWS units are 14-man teams composed of forecasters and observers who deploy with Army corps and divisions and provide support to tactical operation centers and major resupply corps, division, and brigade airfields.

AWS responsibility does not end with accurate forecasting. In cooperation with the National Weather Service and the Navy, it maintains a joint library of weather data to assist climatologists in operational and logistical planning.

More than a billion observations are available from this weather library which receives and stores approximately 40 million observations annually.

Through U.S. membership in the World Meteorological Organization, AWS cooperates with weather services of other nations in helping maintain a free and necessary flow of weather data from nation-to-nation and from continent-to-continent.

Reserve Components

There are 39 Air National Guard (ANG) weather flights stationed throughout the U.S. ready to supply backup manpower, should the need arise for mass deployment of Air Force weathermen. Thirty-one ANG units are trained to support the Air Force and 8 to support the Army.

An AWS headquarters detachment, located at Langley AFB with the 200th

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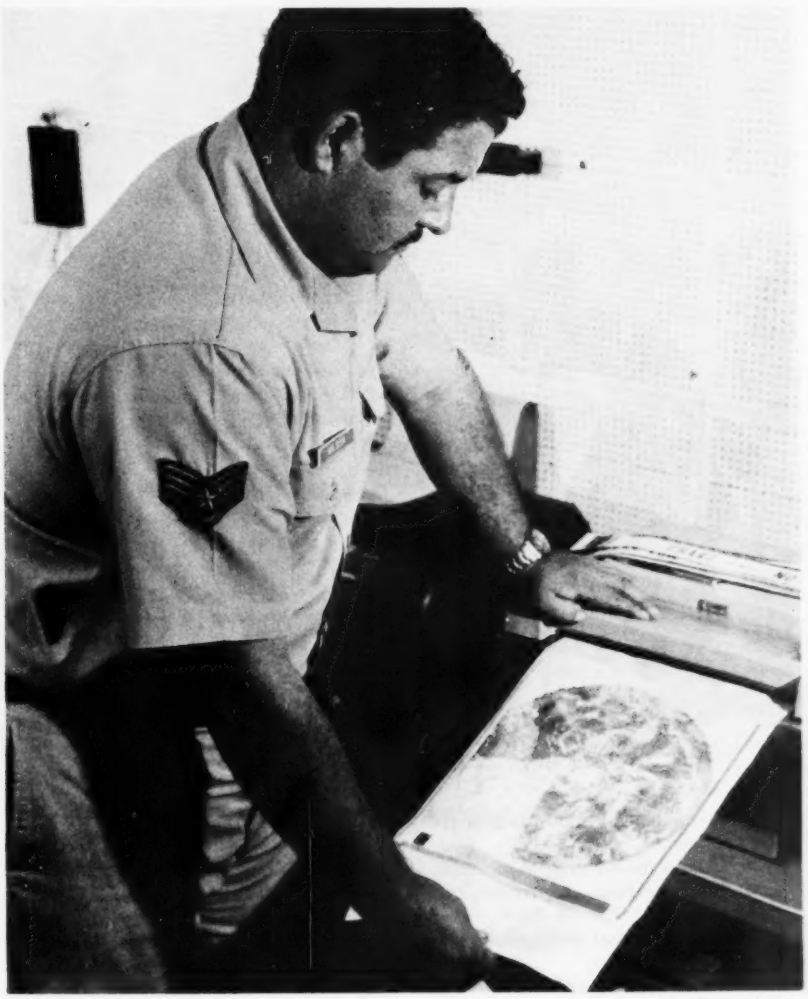
Weather Squadron, is the advisory unit for all ANG weather flights. Each flight has the assistance of a member of this detachment, an active-duty noncommissioned officer who serves as Reserve Forces Technical Advisor (RFTA). The RFTA supervises training, helps administer and maintain facilities, and assists in recruiting new flight members.

As for the Air Force Reserve, AWS has a Reserve Mobilization Augmentee (MA) program designed to provide additional weather personnel in time of war or national emergency. The MAs participate on a voluntary basis and are attached to active-duty AWS weather units near their homes for training. This resource of qualified weathermen can augment AWS on short notice.

Operating from bases in California, New Mexico, Mississippi, Guam, Hawaii, and Japan, USAF aircraft fly nearly 23 million miles each year.

Over-water reconnaissance aircraft are equipped with devices called dropsondes. Parachute-borne instrument packages are released from the aircraft periodically through a pressure hatch. As a package descends toward the surface, it transmits coded signals denoting atmospheric pressure, temperature, and humidity at various altitudes back to the aircraft.

The aircrew relays the dropsonde data to a ground control station, where readings are checked and retransmitted to weather units via weather communications circuits.



U.S. Air Force Photo

WEATHER SATELLITES—An Air Force weather observer at Norton Air Force Base, California, tears off an ESSA (Environmental Science Services Administration) satellite weather picture. Weather satellites provide an added dimension in weather forecasting.

Hurricane Hunters

One of the most dramatic and demanding assignments for AWS aircrews is reconnoitering tropical storms. Hurricane reconnaissance began in May 1944, and 16 Atlantic storms were tracked during that first season. AWS began tracking Pacific typhoons in September 1947.

To obtain vital storm data, crews of the 53rd, 54th, and 55th Weather Reconnaissance Squadrons (WRS) fly their aircraft into the center or "eye" of hurricanes and typhoons. Known as the USAF Hurricane Hunters, the 53rd operates out of Keesler AFB, Mississippi. The USAF Typhoon Chasers of the 54th WRS, Andersen AFB, Guam, watch Pacific storms. The 55th WRS at McClellan AFB is equipped with WC-130 and WC-135 aircraft which perform similar missions off the coast of California. The WC-135s do not penetrate the tropical storms.

From June through November, the normal hurricane season, Hurricane Hunters fly selected tracks, up to 3,000 miles in length, into the breeding grounds of tropical storms. Pacific typhoon reconnaissance continues virtually the year around.

The storm reconnaissance flights enable the flying weathermen to discover or confirm storms in their earliest stages. During out-of-season months, the reconnaissance crews continue to fly daily missions over the ocean expanses to make observations of value to ship and air traffic.

In 1969 the 53rd WRS began flying winter-storm reconnaissance missions along the Atlantic seaboard to help the National Weather Service forecast snowfall more accurately on the East Coast.

Army Meteorology

Solving Problems Related to Weapons Systems, Operations

Just over 100 years ago, in 1870, a weather section was formed in the U.S. Army's Signal Service. That first national weather service grew out of a joint Congressional Resolution, signed by President Grant, which directed the Secretary of War to, "Establish a service for meteorological observation and for giving notice of the approach and force of storms."

The Army is still very much in the meteorological business, conducting a Research, Development, Test and Evaluation (RDT&E) program concerned with developing techniques and equipment for solving Army problems and providing near real-time meteorological information related to weapons systems and operations.

Operational environmental services support to the Army is provided by a combination of Army and Air Force environmental service units. At the Department of Army, the Assistant Chief of Staff for Intelligence (ACSI) has general staff responsibility for environmental services to include operational support, monitoring training and schooling, and approving plans, policies, weather service requirements, concepts and doctrine.

Operational weather forecasting is provided to the Army by the U.S. Air Force's Air Weather Service (AWS). However, the Army meets its own requirements for such operations as:

- Meteorological observations and soundings in the support of artillery weapons systems,
- Meteorological observations forward of division headquarters elements, except at some designated airfields,
- Specialized meteorological support to Army research and development activities, and
- River-stage and flood forecasting.

To support artillery weapons systems, there is one meteorological section located in each division, and two additional sections at each corps level. These sections are capable of generating five types of meteorological messages:

- NATO ballistic meteorological message,
- Computer ballistic meteorological message,
- Fallout meteorological message,
- Sound-ranging meteorological message, and
- Meteorological message for the Air Weather Service.

The ballistic messages allow artillerymen to make corrections for wind, tem-

U.S. Army Photo

OPERATIONS—These Army Arctic infantrymen depend on accurate local weather forecasting in order to fill operational needs. The Army meets its own requirements for meteorological observations forward of division headquarters elements, except at some designated airfields.

perature, and atmospheric density any of which can cause a projectile to miss its intended target. The fallout message allows the corps chemical officer to plot the areas of nuclear fallout, while the sound-ranging message allows enemy weapons to be located by the sound of their firing.

The Army meteorological sections provide data which is assimilated with other environmental data in order for the Air Force to make accurate weather forecasts. There are 24 such sections in the Army today; there were more than 60 during the Vietnam War.

Atmospheric processes have a significant impact on Army operations. The principal objective of the Army's atmospheric sciences program is the acquisition and utilization of knowledge required for effective use of weapons systems, conduct of Army operations, and support of DoD RDT&E programs.

The general areas emphasized in Army meteorology are: micro- and meso-meteorology, atmospheric sensing, meteorological satellite applications, upper atmosphere, meteorological techniques and equipment, and meteorological support activities.

Local Forecasting

Micro- and meso- meteorology concerns Army meteorologists since Army operations are affected principally by local weather phenomena because of the relatively small area over which they are conducted. The objectives of this research are to provide detailed information on the properties of the lower atmosphere within the battlefield area. Models to describe mesoscale systems, boundary layer phenomena, and effects of terrain on atmospheric structure are developed and tested.

Studies also are conducted on the effects of meteorological conditions, especially as influenced and modified by terrain, on the processes of atmospheric transport and diffusion. Information obtained has direct application to problems associated with air pollution abatement.

Remote-sensing offers the possibility of continuous real-time surveillance of atmospheric parameters and the capability to obtain meteorological information at any time and place. Use of laser radars, radiometers, microwave radars, and acoustic systems as remote atmospheric sensors will be evaluated.

Studies of atmospheric transmissivity in controlled atmospheres will be performed at laser wavelengths. Effect of atmospheric particulates on laser propagation is also under study. Investigations continue on the use of lidar to determine the occurrence, distribution, size and composition of atmospheric particulates.

Questions and Answers

Looking at Defense Weather Forecasting

Commanders Digest: Who provides operational forecasting to the Army?

Answer: *This is provided by the Air Force Air Weather Service, but the Army meets its own requirements for such operations as meteorological observations and soundings in support of artillery weapons systems, meteorological observations forward of division headquarters elements, specialized meteorological support to Army research and development activities and river-stage and flood forecasting.*

CD: How does the Army assist the Air Force to make accurate weather forecasts?

A: *Army artillery meteorological sections provide data to Air Force forecasters. There are 24 such sections in the Army today.*

CD: What is the principal objective of the Army's atmospheric sciences program?

A: *The acquisition and utilization of knowledge required for effective use of weapons systems, conduct of Army operations, and support of RDT&E programs.*

CD: Why is micro- and meso-meteorology of concern to the Army?

A: *Because of the relatively small area over which they are conducted, Army operations are affected principally by local weather phenomena.*

CD: How does an Army corps or division commander obtain *AWS tactical weather?*

A: *AR 115-12 describes the statement of requirements (SOR) he must submit to obtain this TO&E supported unit.*

CD: What additional specialized functions have been assigned to the Fleet Weather facilities of the Navy's Fleet Weather Central?

A: *Keflavik and Quonset Point provide detailed support for anti-submarine warfare operations, Jacksonville deals with hurricanes and Suitland, Maryland, concentrates on ice forecasting and meteorological satellite interpretation.*

CD: What is the reason for the Navy's Fleet Numerical Weather Central at Monterey, California?

A: *It was the result of the Navy's realization that the sheer volume of data involved in global environmental analysis and forecasting, and the inevitable advances in related techniques, could only be handled by numerical means.*

CD: What are some of the products of the meteorological services in the Navy?

A: *High winds and high seas warning, hurricane and typhoon forecasts, en route weather forecasts for individual ships and forces and ice forecasts.*

CD: What is the purpose of optimum track ship routings?

A: *This service, developed by the Naval Oceanographic Office and operated by the Naval Weather Service Command, integrates anticipated sea and weather conditions with individual ship characteristics and operating constraints to select a safe, least-time track for a given ship voyage.*

CD: What does the Air Force do in the way of storm warnings?

A: *Weather crews and aircraft based in Louisiana, California, Guam and Japan fly tropical storm-reconnaissance missions each season to collect data for use in providing advance warnings of the location, intensity, and structure of hurricanes in the Atlantic, Caribbean, Eastern Pacific, and of typhoons in the Western Pacific.*

CD: What is the backbone of the military weather communications system?

A: *The Automated Weather Network consisting of four real-time communications switching computers at Carswell AFB, Texas, RAF Croughton, England, Fuchu Air Station, Japan, and Clark Air Base, the Philippines.*

ARMY WEATHER DATA—An Air Force airborne weather observer free-falls from a U-10 aircraft during a weather mission at Hurlbert Field, Florida. Operational weather forecasting is provided to the Army by the Air Force's Air Weather Service.

U.S. Air Force Photo

A technique has been developed for using helicopter downwash to dissipate local warm fogs. A "Lesson Plan" was prepared for this technique and is being used by Army helicopter pilots. The technique was first used successfully in Vietnam for rescue and re-supply operations.

Development of a mobile propane dispenser for dissipation of local supercooled fogs will continue.

Investigations of atmospheric electrical structure near cumulus clouds will also go on to determine possible effects on electromagnetic sensors.

Research in the area of aeronomy is intended to acquire new knowledge of the properties and dynamic processes of the atmosphere that affect the propagation of electromagnetic energy and the design and operation of missiles and rockets.

Major efforts include development of special instruments for conducting in situ high altitude measurements in the ionosphere, especially in and above the D-region, to determine total electron content, electron density, and the earth's magnetic field. Studies continue in investigating methods of measuring the electrical and chemical properties of the ionosphere, measuring ionospheric reaction rate constants in laboratory experiments, and incorporating reactions into computer codes to produce models of the atmosphere.

The ultimate goal of this research is to provide better prediction of the duration of electromagnetic blackout in the upper atmosphere following a natural or man-made disturbance. Studies on the effect of meteorological processes on the thermal, chemical, and electrical structures of high-altitude regions will continue.

The meteorological techniques and equipment program is designed to provide techniques and equipment essential to meteorological support of combat operations. Work will continue on development of improved meteorological corrections for sound ranging and determination of improved meteorological data. Studies will be initiated on the development of weather radar techniques and will continue on meteorological satellite techniques for Army applications.

Development of meteorological equipment will continue, involving equipment such as automatic atmospheric sounding systems, fast-rise balloon system, portable automatic weather observing station, and the portable radar for wind measurement.

The meteorological support program provides meteorological support to DoD RDT&E activities and other organizations and to users of the White Sands Missile Range, New Mexico. Detailed meteorological data are obtained from the surface to 300,000 feet, using standard and special purpose meteorological instrumentation.

To illustrate the extent of this program, in 1971 meteorological support was provided for 651 programs of 75 Army RDT&E activities at 10 permanent sites and for 18 programs at temporary sites.

Meteorological support was provided for 120 RDT&E programs at White Sands Missile Range, (Army, Navy, Air Force, and NASA), involving approximately 4,500 range missions. This program included the Army's participation in the Cooperative Meteorological Rocket Network. Support also is provided to the Army's demilitarization and detoxification activities, as well as to the National Hail Research Experiment and to the International Field Year of the Great Lakes.

In addition to the operational and RDT&E meteorological support activities, the Army is careful to ensure that none of its projects or activities have irreversibly harmful effects upon the atmosphere. In compliance with the National Environmental Policy Act (NEPA), all environmental impacts are carefully assessed in the planning stages of all Army operations.

The Army shares its meteorological knowledge and techniques with foreign nations through a number of international organizations. These are:

- The NATO Army Armaments Group, Panel XII (Meteorology),
- Canada-U.S. Regional Planning Group, Meteorological Committee,
- Canada-U.S. Military Cooperation Committee, Meteorological Subcommittee, and
- The Quadripartite Working Group on Meteorology.

Most Army meteorologists are trained by the Meteorology Division of the Target Acquisition Department at Fort Sill, Oklahoma. However, airfield tower operators and Army aviators do get some meteorological instruction at Fort Rucker, Alabama. The Army sends commissioned officers to civilian institutions to obtain advanced degrees in meteorology.

There are about 85 officers and warrant officers involved with meteorology in the Army. In addition, there are 695 enlisted men and 95 civilians. These figures do not include some 630 U.S. Air Force meteorological personnel who support Army operations on a full-time basis.

Naval Weather Service

Meets Important Environmental, Oceanographic Needs

The Naval Weather Service system functions as a specialized professional team of environmentalists, attached to various naval commands, for the common purpose of providing services to meet Navy environmental requirements and Department of Defense oceanographic requirements and operates under common policy directives and utilizes common equipment.

The Naval Weather Service system embraces:

- Weather Service personnel attached to such combatant vessels as carriers, cruisers, guided missile ships, etc;
- Environmentalists attached to the staffs of force and fleet commanders;
- Weather offices, manned by Marine personnel supporting Marine aviation and ground forces;
- A weather reconnaissance squadron in the Atlantic; and
- The Naval Weather Service Command, its training, logistic, and materiel support commands.

The Naval Weather Service Command, the most important and largest single components of the system, provides air-ocean prediction services, and is primarily involved with the basic functions of centralized analysis, prognosis, and interpretation.

The concept of a functional prediction service to meet Navy requirements in this area has its historical beginnings and precedence in the U.S. Marine Meteorological Service, established in the 1800s and in the Aerological Service, which the Chief of Naval Operations directed the Bureau of Navigation in 1919 to establish and maintain. From this background and progressing through several organizational changes during and subsequent to World War II, the present Naval Weather Service Command, established by the Secretary of Navy in July 1967, has evolved.

Command Channels

The command, with its headquarters, is a line organization directly under the Chief of Naval Operations. It commands four computer-equipped Fleet Weather Centrals—Guam, Pearl Harbor, Norfolk and Rota. Each has geographical areas within which each collects environmental observations, processes data, and disseminates area analyses, prognostic charts and warnings.

Within each Weather Central's area of responsibility are eight Fleet Weather Facilities, plus an additional Central at Alameda in the San Francisco Bay area. Facilities assist the Weather Centrals in accomplishing their missions, provide support to local aviation operations, and at most locations—Alameda included — additional specialized functional responsibilities have been assigned.

For example, Keflavik, Iceland, and Quonset Point, Rhode Island, provide detailed support for anti-submarine warfare operations, Jacksonville, Florida, deals with hurricanes, and Suitland, Maryland, concentrates on ice forecasting and meteorological satellite interpretation.

Naval Weather Service Environmental Detachments (NWSEDs) are assigned to Fleet Weather Centrals and Facilities. The primary function of the 53 detachments is to support aviation operations of all types, including anti-submarine warfare environmental support to colocated patrol aircraft.

Automated Data Processing

More than 10 years ago, the Navy realized that the sheer volume of data involved in global environmental analysis and forecasting, and the inevitable advances in related techniques, could only be handled by numerical means. In order to move the Navy into the era of computerized environmental products, a Fleet Numerical Weather Central at Monterey, California, was added to the Weather Central complex. Today, as the operational hub of both the Naval Weather Service system and the Com-

FLEET WEATHER—U.S. Navy Aerographer's Mate Third Class Sharon L. Germillion makes weather code notations on a map in the Fleet Weather Central at Alameda, California. A Fleet Weather Central is comprised of eight Fleet Weather Facilities.

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A Navy WP-3A Orion from Weather Reconnaissance Squadron Four during a weather reconnaissance mission.

mand, it has hemispheric meteorological and oceanographic responsibilities—producing analyses and forecasts for direct operational use and in support of all elements of the system.

The Naval Weather Service Command is comprised of a Headquarters, 5 Weather Centrals, 8 Weather Facilities, 53 Environmental Detachments and 1 Fleet Numerical Weather Central. The command collects environmental observations from all over the world, including observations from the Naval Weather Service.

Both meteorological and oceanographic observations are transmitted to the Fleet Numerical Weather Central at Monterey, where they are quality-checked, sorted and edited by automated programs. Then, the analysis and prognosis functional programs take over, and basic processed data are transmitted to the Fleet Weather Centrals, computer-to-computer at the equivalent of 4,000 to 6,000 teletype words per minute. At the same time, the Centrals are returning to Monterey their own observations and any that they have collected from ships in their areas.

At the Centrals, data fields of interest are automatically extracted, supplemented with local data, interpreted, and formatted as required for customer use, and then disseminated by radioteletype, radio facsimile, or data link to other Naval Weather Service Command units, and ultimately to the Fleet, Marine Corps units, and Naval Air Stations. The interpretation function is performed by the Naval Weather Service system prior to dissemination to fleet consumers.

Most of the analysis and dissemination processes are completely automatic, utilizing modern computer and ancillary equipment, coupled with a highly efficient three-continent, high-speed communications linkage called the Naval Environmental Data Network. The main trunks emanate from the computer complex at Monterey, connecting with computers at Guam, Pearl Harbor, Norfolk, and Rota. From Norfolk and Monterey, the trunks fan out along the east and west coast tielines which extend from San Francisco to San Diego on the West Coast and from Brunswick, Maine to Key West, Florida on the East Coast.

These terminal stations are concerned primarily with anti-submarine warfare or control of operational forces. There are some non-Navy users too—the National Weather Service, the Air Force, the Coast Guard, the Woods Hole Oceanographic Institute, and the National Marine Fisheries Service. The terminals are all connected to remote automatic X-Y plotters which provide hard copy map analyses and prognoses.

The bulk of the meteorological data input required to support this system flows through the Air Force Automated Weather Network down to Carswell AFB, Texas, and ultimately to Monterey. This relationship has proved extremely effective, allowing the Navy to specialize in product dissemination to afloat forces. Ongoing projects continue to enlarge the scope of Navy and Air Force cooperation.

Ocean Environment

A variety of analyses and prognostic weather charts is generated to provide Fleet forces with a three-dimensional hemispheric picture of the air-ocean environment in which they are operating. These charts are used in the conventional way by environmental forecasters to provide necessary services to the Fleet. Products in the meteorological service area include:

- High winds and high seas warnings,
- Hurricane and typhoon forecasts,
- Ice forecasts, and
- En route weather forecasts for individual ships and forces.

Supplementing this material are a number of products and services tailored specifically for such unique naval operations as the following:

- Amphibious landings. These require a variety of parameters: height, type and period of breakers; width of surf zone, and littoral currents.
- Carrier operations. These concern strike forecasts en route winds at flight altitude, ceilings and visibilities, ditch headings, etc.
- Fire support operations. These require ballistic winds and density for accurate firing of guns and missiles.
- Underway replenishment operations. A tailored product here provides a measure of the anticipated difficulty—or risk—of replenishing one ship from another while underway.
- Optimum track ship routings. This service, developed by the Naval Oceanographic Office and operated by the Naval Weather Service Command, integrates anticipated sea and weather conditions with individual ship characteristics and operating constraints to select a safe, least-time track for a given ship voyage. Units of the Naval Weather Service Command route approximately 4,500 ships per year.

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